Congestion cost analysis of Condongcatur signalized intersection Sleman, D.I. Yogyakarta using PTV. Vissim 9

by Muchlisin Muchlisin

Submission date: 16-Jul-2020 08:20AM (UTC+0700)
Submission ID: 1358026902
File name: Congestion_Cost_Analysis.pdf (533.43K)
Word count: 2253
Character count: 11042

MATEC Web of Conferences **181**, 06003 (2018) https://doi.org/10.1051/matecconf/201818106003
ISTSDC 2017

Congestion cost analysis of Condongcatur signalized intersection Sleman, D.I. Yogyakarta using PTV. Vissim 9

Muchlisin[1,*], *Muhamad* Yusup[2], and *Noor* Mahmudah[1]

[1]Muhammadiyah University of Yogyakarta, Depart of Civil Engineering, Jl. Brawijaya, Indonesia

Abstract. The congestion cost is one of the most important consideration when congestion happens. One of the most frequent congestion is in the intersection. And one of the intersections in Yogyakarta Special Region is Condongcatur signalized intersection, Sleman. This study aims to analyze the congestion cost of intersection by using PYV. Vissim 9 as a traffic microsimulation model. For the congestion costs, the author uses Tzedzakis, 1998 approach. The results show that in the existing condition, the average delay is 103.72 determining Vehicle Operating Cost (BOK), Existing Speed is 70 km/H for primary road and 60 km /H for secondary road, travel time value is KB : Rp. 4.970, KR: Rp. 1.925 and SM : Rp. 315. Therefore, the total congestion cost is Rp. 5.663.790, -/hour.

1 Introduction

The congestion cost is one of the most important consideration when congestion happens. One of the most frequent congestion is in the intersection. And one of the intersections in Yogyakarta Special Region is Condongcatur signalized intersection, Sleman. Condongcatur signalized intersection is a North Ringroad of Yogyakarta which is a connector between Provinces of Central Java and an access road to the city of Yogyakarta.

In this study, the author tries to approach how much the cost incurred in the signalized intersection. According to Stubs in Sugiyanto [1], he mentions that the cost of congestion is a relation between speed and flow on the road and the relation between speed and vehicle cost. If the existing traffic flow limit is exceeded, then the average traffic speed will decrease. When the speed starts to fall, then the vehicle operating costs (BOK) will increase in the range of 0-45 miles / hour and the time to travel wil increase. But in case at a signal intersection, not all vehicles have speed due to delay on traffic light effects.

Corresponding author: muchlisin@umy.co.id

Therefore, in this study the author uses simulation results from PTV. Vissim 9 student version as the diciding factor of the intersection delay. The intersection delay is used to predict how much it will cost. Vehicle operating costs (BOK) in this study refers to Sugiyanto [2], which has made an approach to determine the BOK from the speed of the vehicle.

2 Methodology

2.1 Framework analysis

The data used in this study is based on field survey and previous study which then modeled using PTV. VISSIM. 9. Flow chart that explain the methodology can be seen in Figure 1.

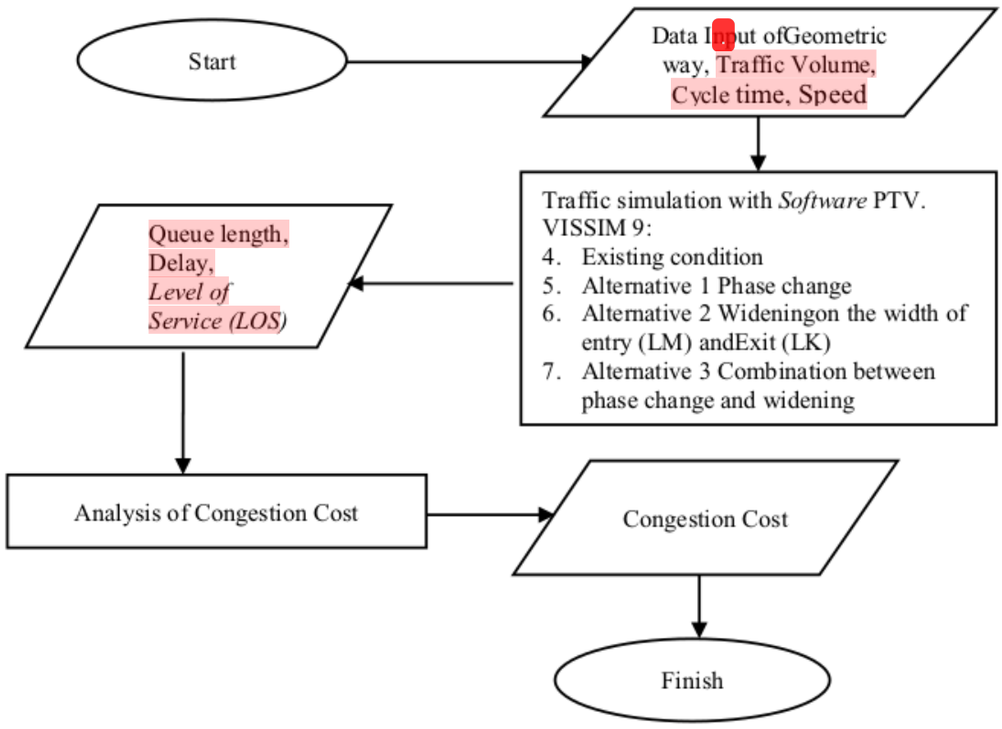


Figure 1. Framework analysis

2.2 Study location

This study is located at Condongcatur Signalized Intersection Sleman, Special Region of Yogyakarta which is a connecting the North Ringroad, Jl. Angga Jaya, and Jl. Affandi (Gejayan). The Location can be seen in Figure 2.

2.3 Study time

The traffic volume used in this study is secondary data on previous study by Maulidiah [3]. Data collection is done for 12 hours on weekdays at 06.00 – 18.00 WIB.meanwhile, in determining the geometric way, cycle time, and environmental conditions are carried out at the observation on Sundays, December 04, 2016. And to determine the speed of the vehicle

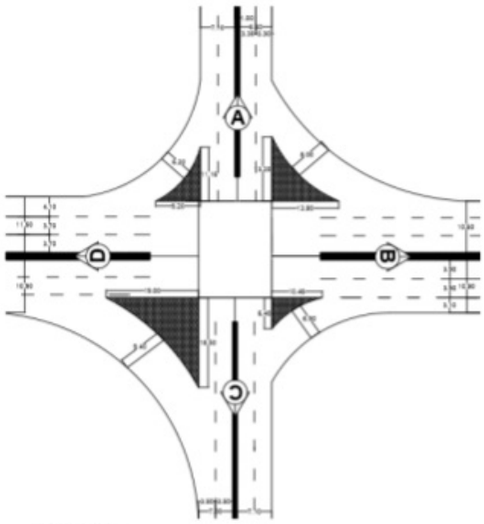
(Spot Speed) conducted on Wednesday, March 22, 2016 which represents the weekday through survey every type of vehicle KB (heavy Vehicle), KR (Light Vehicle), and SM (Motorcycle). The study was conducted with survey in the morning at 06.00 – 08.00 WIB, 11.00 – 13.00 WIB, and in the afternoon 16.00 to 18.00 WIB.

Figure 2. The study location (Source: Google Earth, 2016)

3 Results and analysis

3.1 Geometric condition

The geometric way in the intersection can be seen at the figure below.



a. Wide of arm North (A) : 7,1 meter
b. Wide of arm East (B) : 10,9 meter
c. Wide of arm South (C) : 6,6 meter
d. Wide of arm West (D) : 11,5 meter

Figure 3. Intersection geometric

3.2 Type of road environment

Type of road environment can be seen at the table below.

Table 1. Type of road environment

Arm Code	Regional Condition	Type of Road Environment
Jl. Angga Jaya (N)	Shopping complex	Commercial
Jl. North Ringroad(E)	Shopping complex	Commercial
Jl. Gejayan (S)	Shopping complex, office complex	Commercial
Jl. North Ringroad(W)	Shopping complex	Commercial

3.3. Phase condition

Phase condition can be seen at the table below.

Table 2. Phase condition

Signal	Arm	Type of Arm	Time (second)			
			Red	Green	Amber	All Red
Phase 1	N	Protected (P)	162	34	3	4
Phase 2	E	Protected (P)	137	59	3	4
Phase 3	S	Protected (P)	167	29	3	4
Phase 4	W	Protected (P)	143	53	3	4
Cycle Time (second)			203			

3.4 Traffic volume

Traffic volume survey conducted by data Maulidiah, E [3]. The survey was taken on Monday, 12 january, 2016 which represent on weekdays condition. This is the traffic volume.

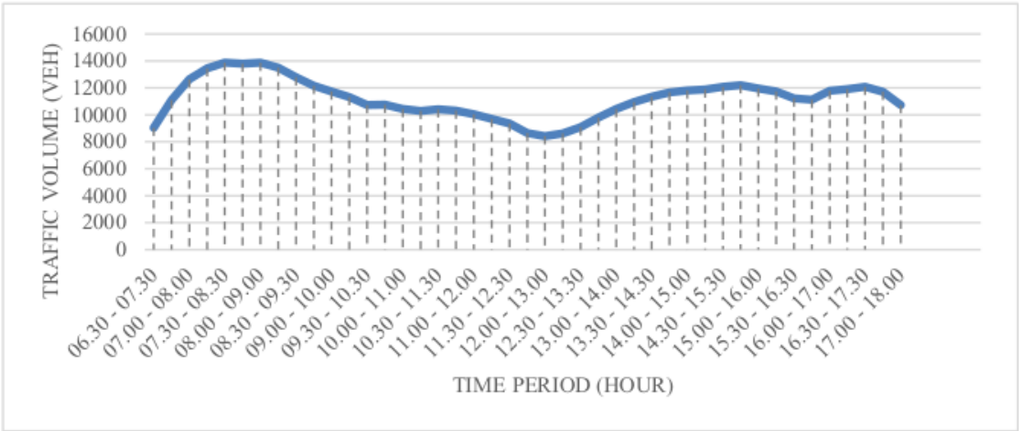


Figure 4. Traffic volume fluctuation

3.5 Traffic modeling by PTV. Vissim 9

This is the flowchart how PTV. Vissim used in this research.

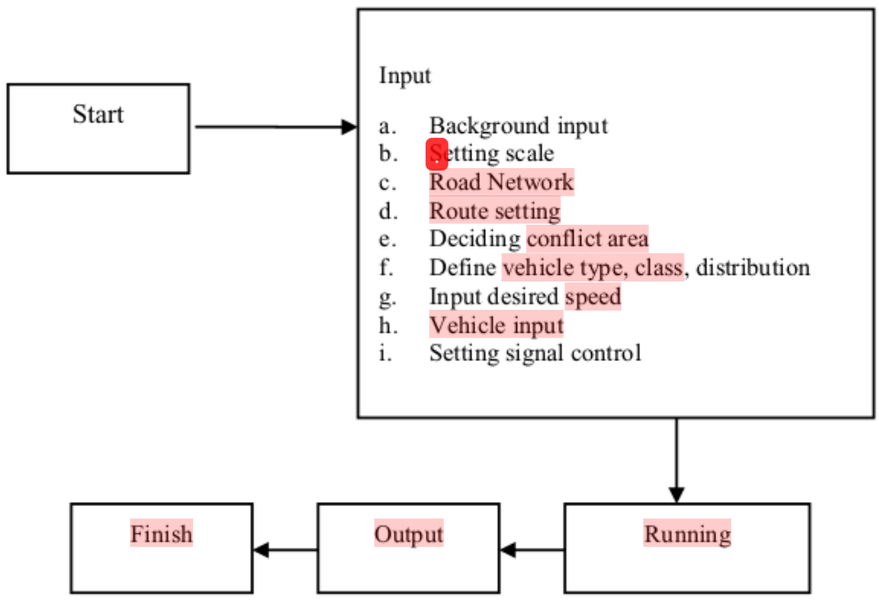


Figure 5. PTV.Vissim 9 process

And this is the output.

Table 2. PTV.Vissim 9 output on existing condition

NO	MOVEMENT	QLEN	QLENMAX	VEHS (ALL)	PERS (ALL)	LOS (ALL)	LOSVAL (ALL)	VEHDELAY (ALL)	PERSDELAY (ALL)	STOPDELAY (ALL)	STOPS (ALL)
1	Jl. Ringroad Utara (B) - Jl. Angga Jaya (U)	0.00	0.00	41.00	41.00	LOS_C	3.00	24.57	24.57	13.79	3.68
2	Jl. Ringroad Utara (B) - Jl. Ringroad Utara (T)	291.55	383.33	131.00	131.00	LOS_F	6.00	139.04	139.04	115.26	4.56
3	Jl. Ringroad Utara (B) - Jl. Affandi (S)	291.55	383.33	60.00	60.00	LOS_F	6.00	174.82	174.82	131.17	11.23
4	Jl. Angga Jaya (U) - Jl. Ringroad Utara (T)	0	0	48	48	LOS_A	1	6.47	6.47	3.01	0.17
5	Jl. Angga Jaya (U) - Jl. Affandi (S)	140.02	167.94	59	59	LOS_F	6	188.52	188.52	157.37	3.75
6	Jl. Angga Jaya (U) - Jl. Ringroad Utara (B)	140.02	167.94	13	13	LOS_F	6	115.25	115.25	94.15	2.46
7	Jl. Affandi (S) - Jl. Ringroad Utara (B)	24.66	148.29	19	19	LOS_D	4	36.57	36.57	21.43	1.68
8	Jl. Affandi (S) - Jl. Angga Jaya (U)	152.48	207.82	59	59	LOS_F	6	208.15	208.15	185.12	3.15
9	Jl. Affandi (S) - Jl. Ringroad Utara (T)	152.48	207.82	55	55	LOS_F	6	197.8	197.8	177.62	2.73
10	Jl. Ringroad Utara (T) - Jl. Affandi (S)	0.01	12.32	105	105	LOS_B	2	15.9	15.9	4.51	0.67
11	Jl. Ringroad Utara (T) - Jl. Ringroad Utara (B)	227.85	365.66	153	153	LOS_F	6	102.98	102.98	83.6	2.27
12	Jl. Ringroad Utara (T)- Jl. Angga Jaya (U)	227.85	365.66	47	47	LOS_F	6	122.59	122.59	99.35	3.55
	Average	**49.38**	**383.33**	**897**	**897**	**LOS_F**	**6**	**103.72**	**103.72**	**83.87**	**3.09**

3.6 Model validation

To test the validation of traffic modeling with Vissim, the author makes correlation with the number of real vehicle and from the model. Let's see the model validation from regression linier analysis with Microsoft Excel 2016.

Table 3. Comparison between the number vehicle from actual survey and from the model

Arm	Direction	Real (veh/h)	Model (veh/15 m)
	LT	671	105
E	ST	2513	153
	RT	600	47
	LT	866	19
S	ST	1059	59
	RT	979	55
	LT	112	41
W	ST	2935	131
	RT	1419	60
	LT	262	48
N	ST	1916	59
	RT	407	13

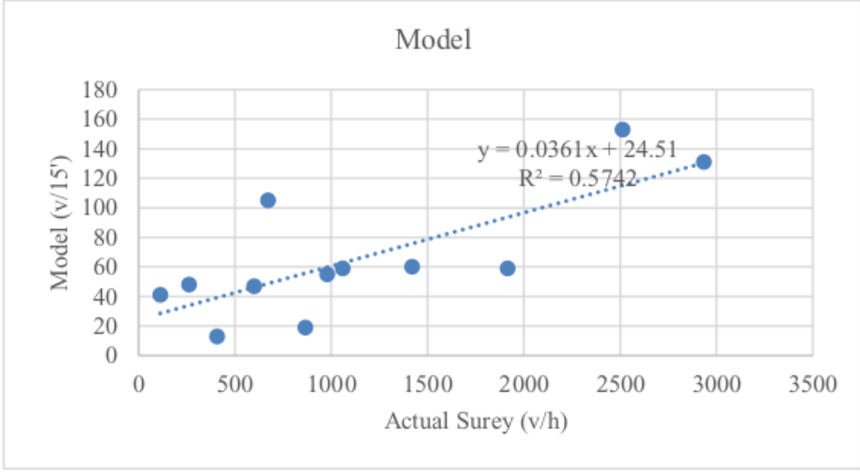


Figure 6. The regression analysis to validate the model

From the figure above, we can see that R square is 0,5742. The author argues that the the model is not too correlate with the real number of vehicle in Gejayan intersection. Because it is not close with 1. The other reason is about the software version. The author uses Student Version from this model. Student Version just only can run in 10 minute simulation.

3.7. Vehicle operating cost

The vehicle operating cost estimate by using Sugiyanto [2, 4] by using references prices at the end of September 2009.

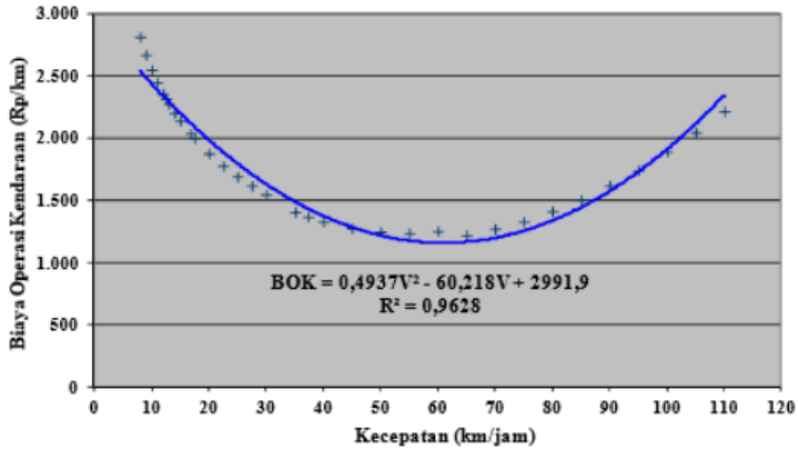


Figure 7. Speed relation and BOK personal car with LAPI ITB method [2]

From the graphic above, thus the BOK for light vehicle and heavy vehicle can be calculated as the equation below.

$$BOK = 0{,}4937V^2 - 60{,}218V + 2991{,}9 \quad (1)$$

With, V = Vehicle speed (Km/Hour)
Based on the vehicle type and arm, this is the result of BOK.

Table 3. Vehicle operational cost

No	Arm	Vehicle Type	BOK (Rp/Veh.km) (G)
1	NORTH	KB	1754.62
		KR	1621.97
		SM	375.07
2	EAST	KB	1207.84
		KR	1207.13
		SM	351.96
3	SOUTH	KB	1219.62
		KR	1177.69
		SM	365.70
4	WEST	KB	1440.24
		KR	1239.61
		SM	351.43

Note:
KB : Heavy Vehicle
KR : Light Vehicle
SM : Motorcycle

3.8 Existing speed (A) and ideal speed (B)

In this study, on the east and West arms which is the primary arterial road based on Government regulation No. 34 of 2006 on the Road is determined to be the lowest at 60 km/h, but based on the survey speed that is done at peak hours speed of 60 km / h is still exceeded, thus determined the ideal speed of 70 km/h to calculate the congestion charge.as for the North and South arms is determined at 60 km/h which is the primary collection road.

3.9 Travel time value (V)

The time value is calculated using the study of Indonesian Highway Capacity Manual [5] with approach of Gross Regional Domestic Product (GRDP). Based on the vehicle type, the time value for heavy vehicle is taken at Rp. M4.970, Light vehicle Rp. 1.925, and Motorcycle Rp. 315.

3.10 Queue and delay Time

The amount of queue or delay time is obtained from the output of VISSIM modeling.

Table 4. Queue and delay time (Vissim output)

No	Arm	Delay (second)	Queue Time (hour)
1	North	103.413	0.0287
2	East	80.49	0.0224
3	South	118.468	0.0329
4	West	112.81	0.0313

3.11 Congestion cost analysis

Congestion cost is a travel expense due to traffic delay or additional vehicle volume approaching or exceeding road service capacity [6]. Using the equation 1-2, then the congestion cost in the existing condition can be seen in Table 5.

$$C = N * \left[GA + \left(1 - \frac{A}{B}\right) V'\right] T \quad (2)$$

where:
C = Congestion cost (Rupiah),
N = Vehicle volume (Vehicle),
G = Vehicle operating cost (Rp/Veh.Km),
A = Existing speed (Km/Hour),
B = Ideal speed (Km/Hour),
V' = Vehicle time value fast (Rp/Veh.Hour),
T = Delay time (Hour).

Table 5. Total congestion cost analysis

No	Lengan	Congestion Cost (Rp/Hour)
1	North	IDR 774,589
2	East	IDR 1,573,246
3	South	IDR 1,351,843
4	West	IDR 1,964,113
Total of Congestion Cost		IDR 5,663,790

4 Conclusion

Based on the results of modeling and analysis using software VISSIM 9 at the signalized intersection Condongcatur Sleman Yogyakarta, it can be concluded as follows.

1. Existing condition of signalized intersection Condongcatur Sleman Yogyakarta shows the highest traffic volume (peakhour) occurred in the morning at 07.30 – 08.30 WIB with average delay rate of 103.72 seconds, average queue length of 49.38 meters, and Level of service level is F (very bad).
2. The costs incurred due to congestion that occurred at the signalized intersection CondongcaturSleman Yogyakarta is Rp. 5.663.790,-/hour at peak hour condition 07.30 – 08.30 WIB.

Acknowledgements

My great gratitude for Dr. Noor Mahmudah, ST. M.eng who had given me advise and support as colleague and mentor in UMY. I also should say thanks very much for Muhamad Yusuf and EstyMaulidiah who help to finish this study. My best tribute to my workplace in Civil Engineering Department, Universitas Muhammadiyah, Yogyakarta.

References

1. Sugiyanto, G.*Biaya Kemacetan (Congestion Cost) Mobil Pribadi di Central Business District. Media Teknik Sipil*(2008).
2. Sugiyanto, G.Pemodelan Biaya Kemacetan Pengguna Mobil Pribadi Dengan Variasi Nilai Aktual Kecepatan Kendaraan. Jurnal Transportasi **Vol.12 No.2**, 123-132 (2012).
3. Maulidiah, E.*Analisis Simpang Bersinyal Condoncatur, Sleman, DIY. UMY: Yogyakarta*(2012).
4. Sugiyanto, G. dkk.Pengembangan Model Biaya Kemacetan Bagi Pengguna Mobil Pribadi di Daerah Pusat Perkantoran Yogyakarta. Jurnal TransportasiVol.**11 No.2**, 87-94 (2011).
5. Directorate General of Highway. *Highway Capacity Manual.Jakarta: Indonesia*(2010).
6. Basuki. Siswandi. Biaya Kemacetan Ruas Jalan Kota Yogyakarta. Jurnal Teknik Sipil***Vol.9 No.1***, 71-80 (2008).

7. Goverment of Republic Indonesia.. *Undang - Undang Republik Indonesia No 22 Tahun 2009 Tentang Lalu Lintas dan Angkutan Jalan*. *Pustaka Yustisia: Jakarta* (2009).
8. Ministry of Transportation Republic Indonesia. *Peraturan Menteri No 96 Tahun 2015. Tentang Pedoman Pelaksanaan Kegiatan Manajemen dan Rekayasa Lalu Lintas*. *Jakarta* (2015).
9. Khisty. Lall. *Dasar- Dasar Rekayasa Transportasi. Erlangga: Jakarta*(2005).
10. PTV VISSION.*PTV VISSIM 9 User Manual. PTV AG : Kalsrhure, Germany*(2016).
11. Sugiyanto, Gito. *Bahan Pembelajaran Mata Kuliah Ekonomi Transportasi. Universitas Jenderal Soedirman: Purwokerto*(2010).

Congestion cost analysis of Condongcatur signalized intersection Sleman, D.I. Yogyakarta using PTV. Vissim 9

ORIGINALITY REPORT

26%	%	26%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

MATCH ALL SOURCES (ONLY SELECTED SOURCE PRINTED)

27%

★ Noor Mahmudah, Rizkie Akbar, Muchlisin. "Analysis of congestion cost at signalized intersection using Vissim 9 (Case study at Demak Ijo Intersection, Sleman)", MATEC Web of Conferences, 2018

Publication

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	Off		